

# Advancing Wire Arc Additive Manufacturing: Tailored Process Solutions for Industry Applications

Prof. Joel Andersson  
Director of Production Technology  
Co-Founder WAAMLABZ

Eivind Vogel-Rödin  
CEO WAAMLABZ



UNIVERSITY WEST

Creating change together.

# University West

- Located in Trollhättan, Sweden
- ~700 employees
- ~14,000 students
- 27 undergraduate programs
- 17 second-cycle programs
- Third-cycle programs in Work-integrated learning and in **Production Technology**



# Complete Academic Environment – Production Technology

Director: Joel Andersson

Deputy directors: Shrikant Joshi & Lennart Malmsköld

1. Mechanical Engineering (ME)
  - Thermal spray (Shrikant Joshi)
  - AM powder bed (Thomas Hansson)
  - Welding and welding based AM (Jörg Volpp)
  - Simulation of Non Destructive Evaluation (Håkan Wirdelius)
2. Industrial automation (IA)
  - Flexible Automation - FA (Fredrik Danielsson/Sudha Ramasamy)
3. Industrial economy (IE)
  - Operations and Supply Chain Management (Henrik Eriksson)

## Short Facts:

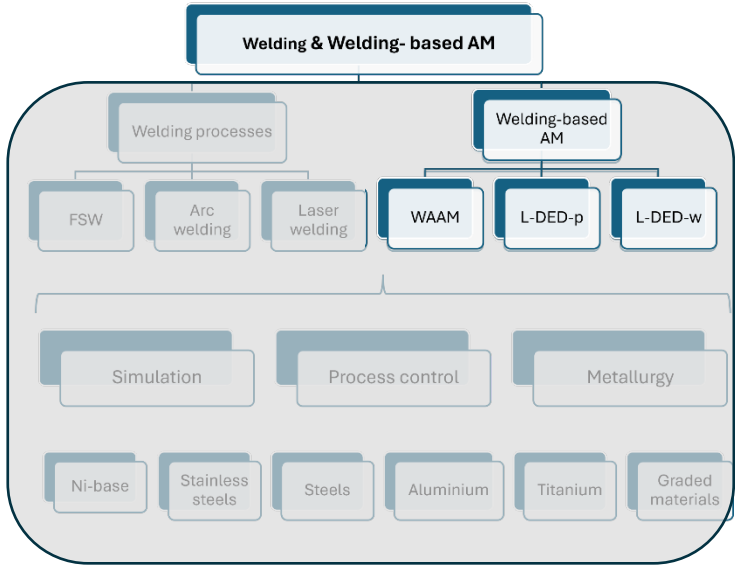
- ~85 researchers
- ~100 MSEK annual turnover
  - 25% internal university funding
  - 75% External funding (Swedish (85-90%), EU (10-15%))
- ~80 companies in collaboration
  
- High ranking in collaboration with industry (Co-authored papers)
  - <https://www.umultirank.org/>

## ***Part of Engineering Science but outside Production Technology:***

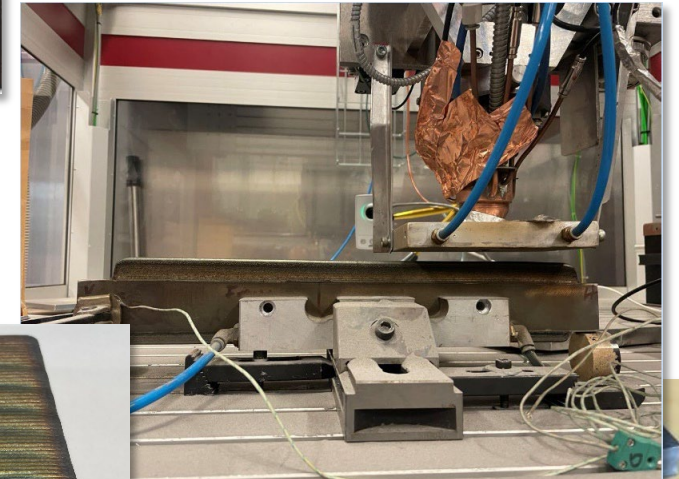
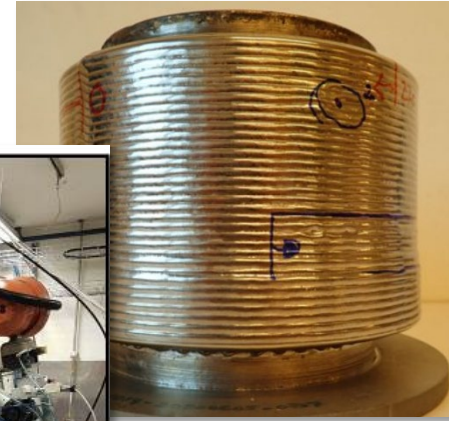
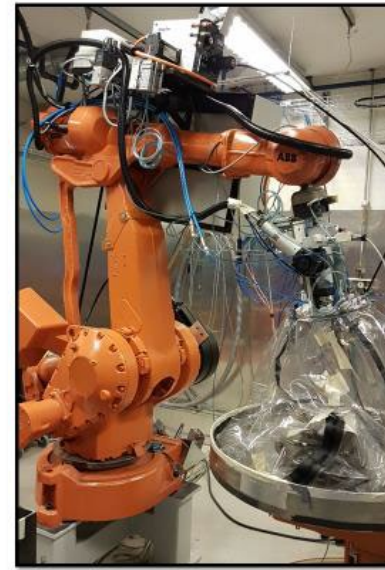
*Computer Engineering (Thomas Pederson)*

*Electrical Engineering (Boel Ekergård)*

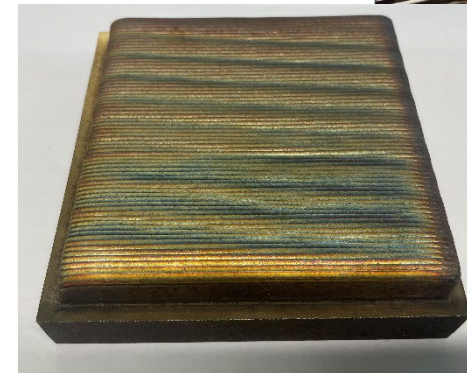
# **Welding based AM**



L-DED-w



L-DED-p



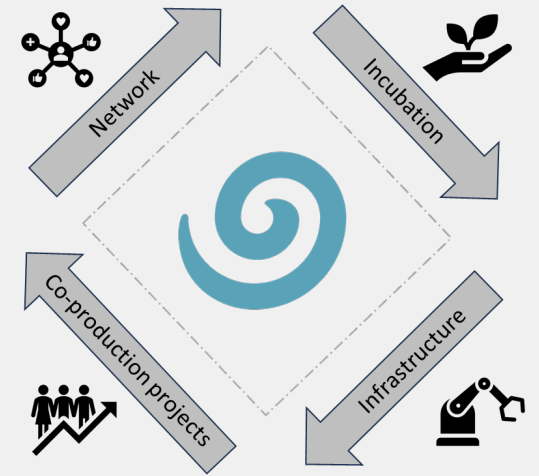
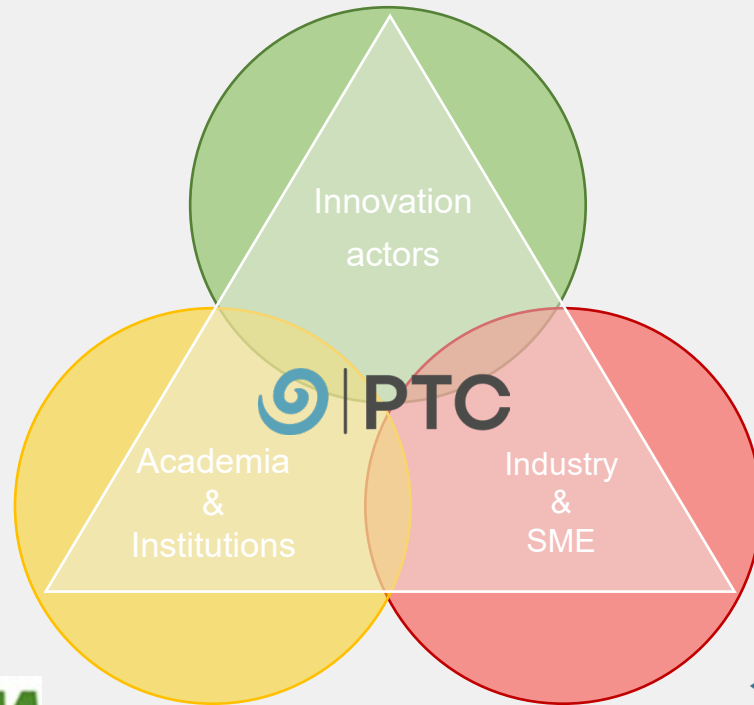
Wire-Arc additive manufacturing (WAAM)





**Ecosystem?**

innovatum  
science  
park



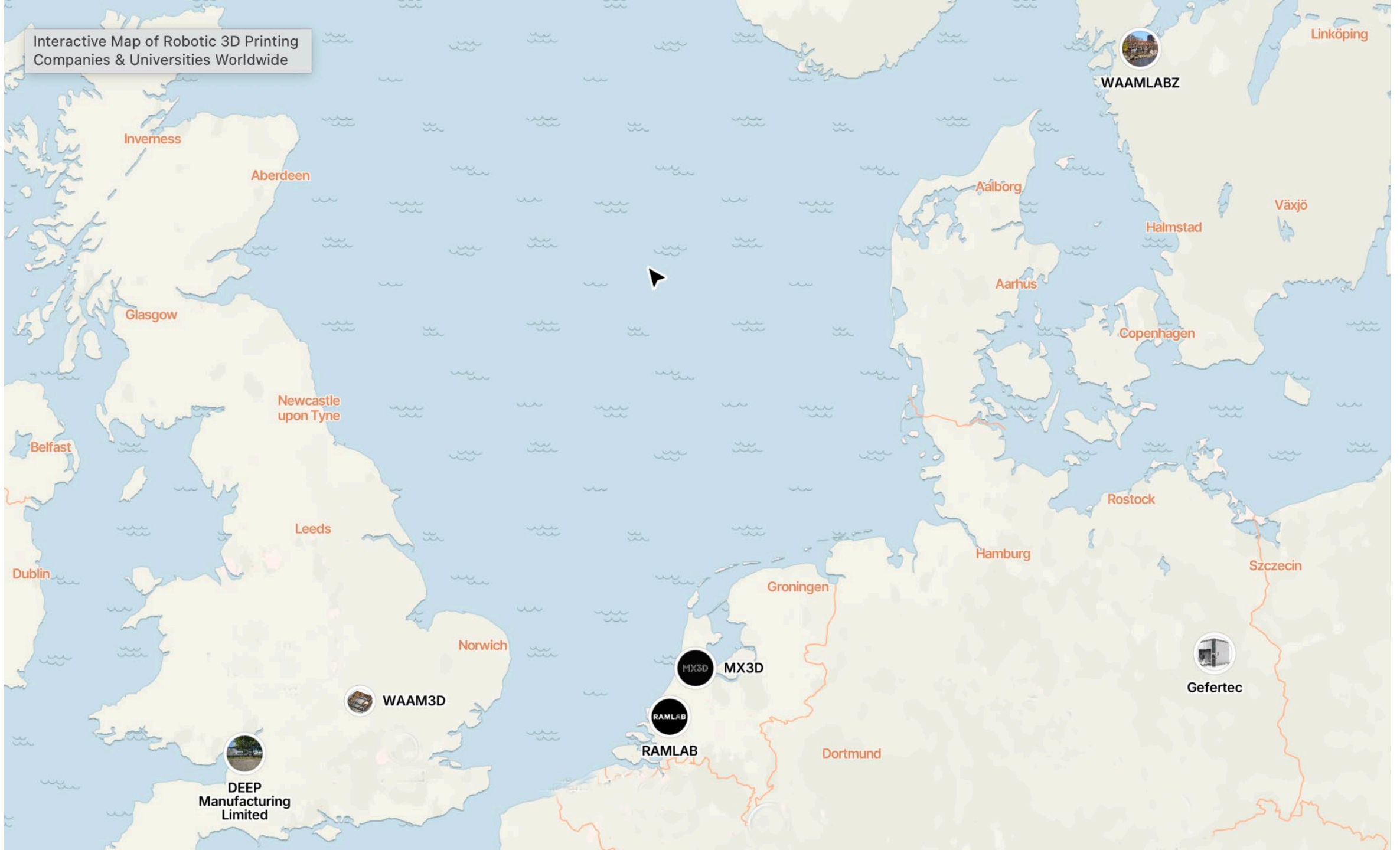
# PTC 2024

- The PTC innovation system generates approximately 100 million Euro annually!
- 800 participants from 150 companies!
- 7 million euro invested in equipment over the past 5 years!
- Main Partners:
  - GKN Aerospace, University West, Swerim, IUC Väst, Innovatum
- Partner Companies:
  - WAAMLABZ (new start-up!), Procada, Brogren Industries, Permanova, Siemens Energy, SSP North, Tricylon, AnVa KSG, Empir Industry, Granitor, Tooltec, Simumatik, Rebl Industries, PTC Innovation, ...



# **WAAM Around the World?**

Interactive Map of Robotic 3D Printing Companies & Universities Worldwide



## NEWS

### MX3D Secures €7 Million to Accelerate Global Growth in Robotic Metal 3D Printing



Amsterdam, The Netherlands – 13th May 2025 – MX3D, a pioneer in robotic metal 3D printing technology, has raised €7 million in a Series A funding round to accelerate its international growth. The funding round was led by EDF Pulse Ventures, the corporate venture investment arm of the French energy leader EDF, with participation from ING Sustainable Investments and the continued support from existing investor PDENH.

# ACCURON TECHNOLOGIES MAKES ADDITIONAL INVESTMENT TO ACCELERATE WAAM3D'S GROWTH

CATEGORY (NEWS)

DATE PUBLISHED 9/1/2024











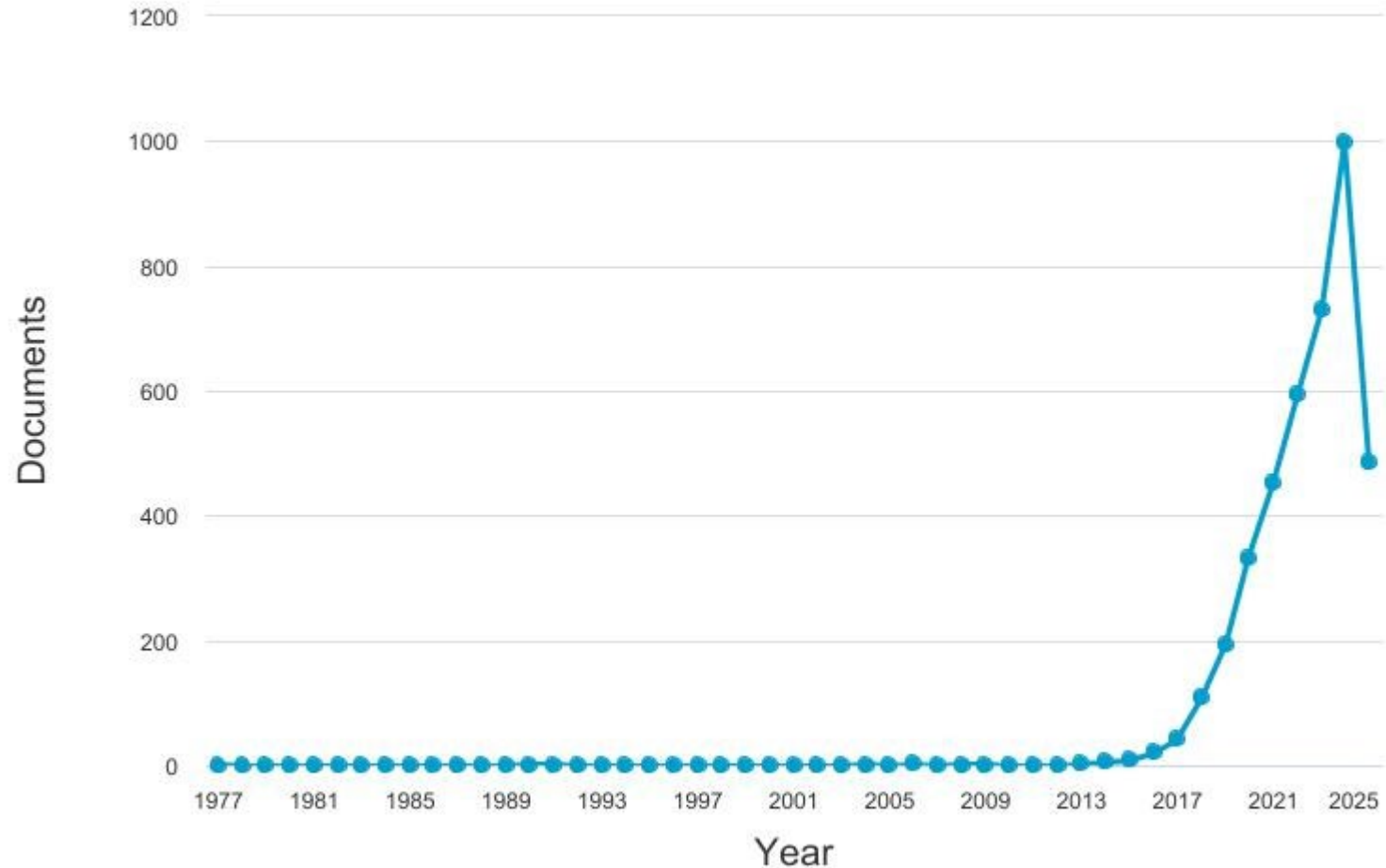
[A 3D-printed metal hook [Image credit: Huisman Equipment]]

**Research on WAAM?**

# Publications WAAM

Documents by year

Scopus

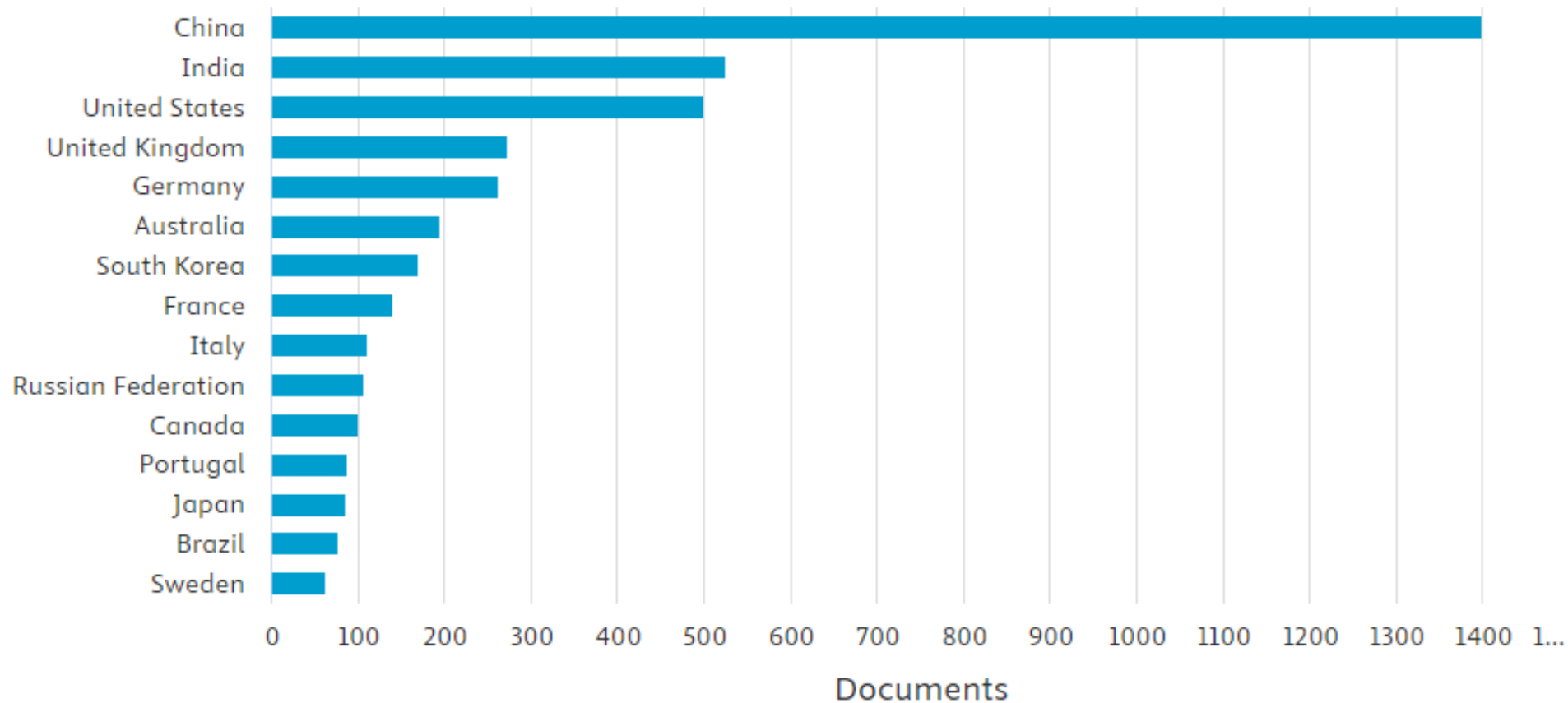


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# Top Countries WAAM

## Documents by country or territory

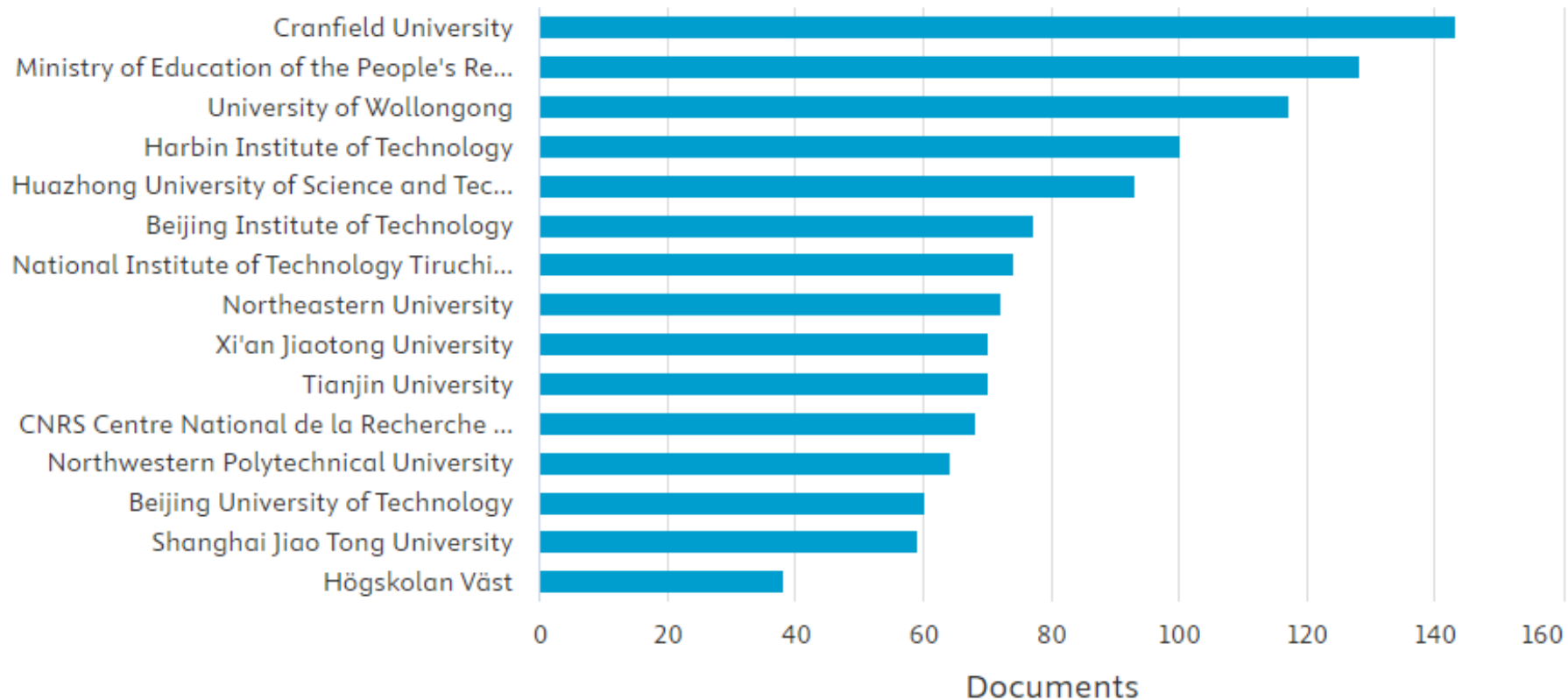
Compare the document counts for up to 15 countries/territories.



# Top Affiliations WAAM

## Documents by affiliation

Compare the document counts for up to 15 affiliations.

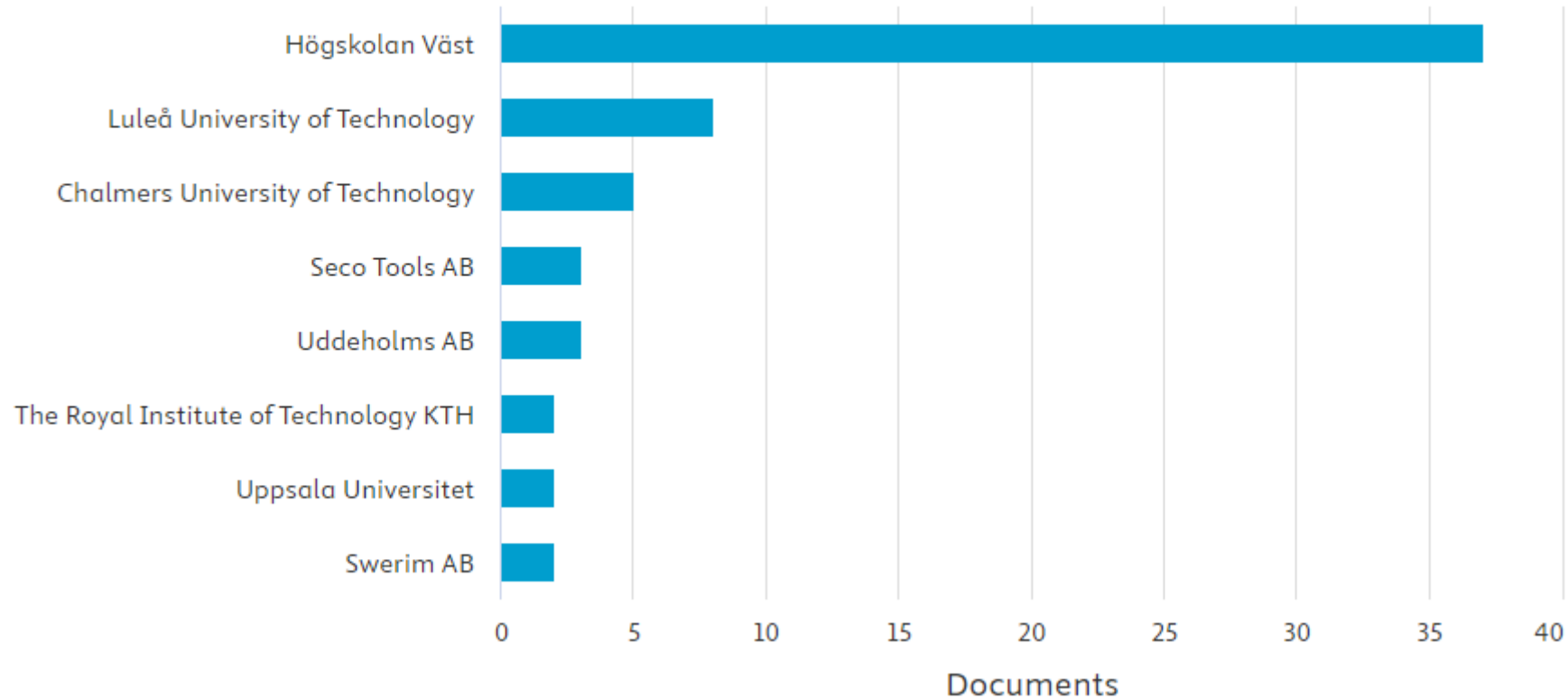


China: 10  
UK: 1  
Australia: 1  
India: 1  
France: 1  
Sweden: 1

# Top Affiliations WAAM - Sweden

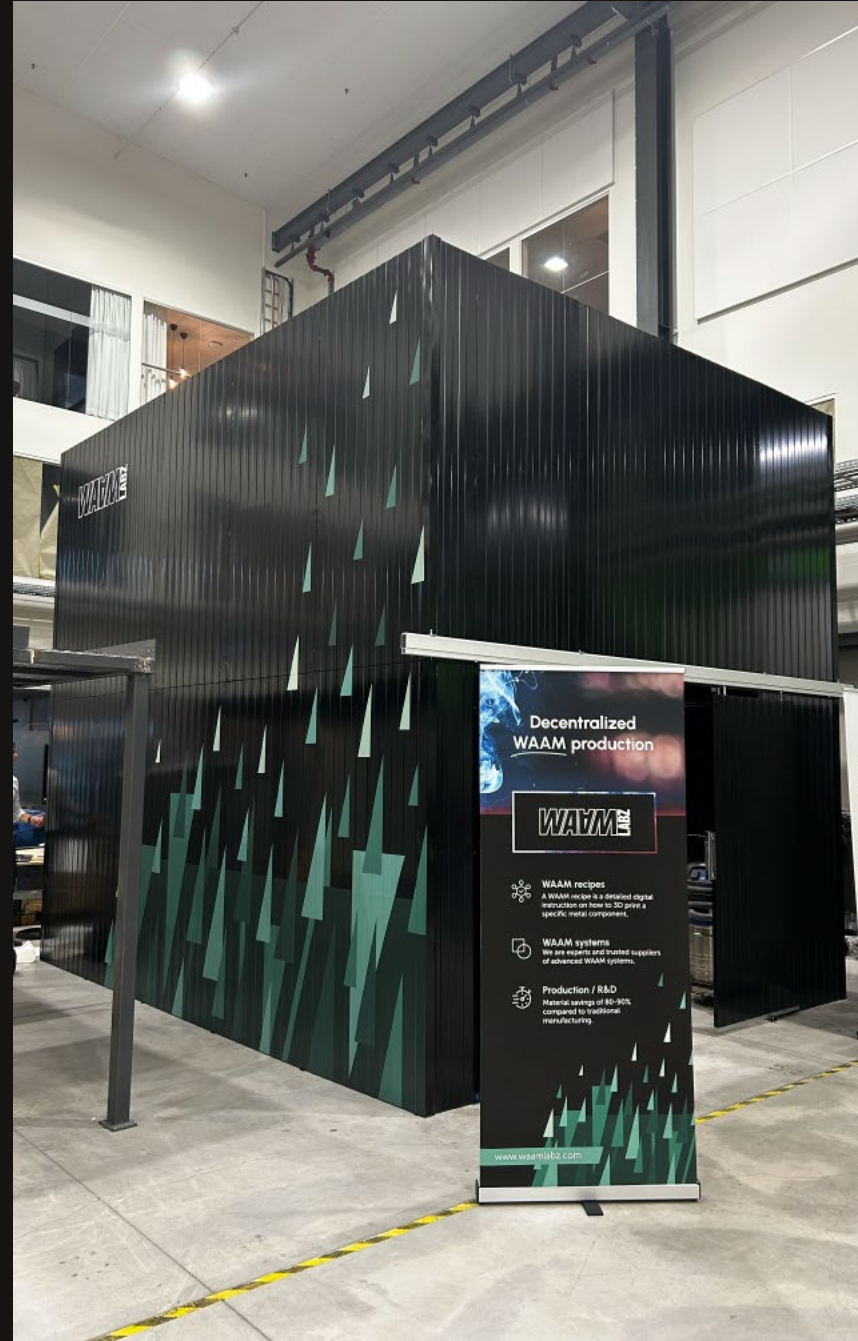
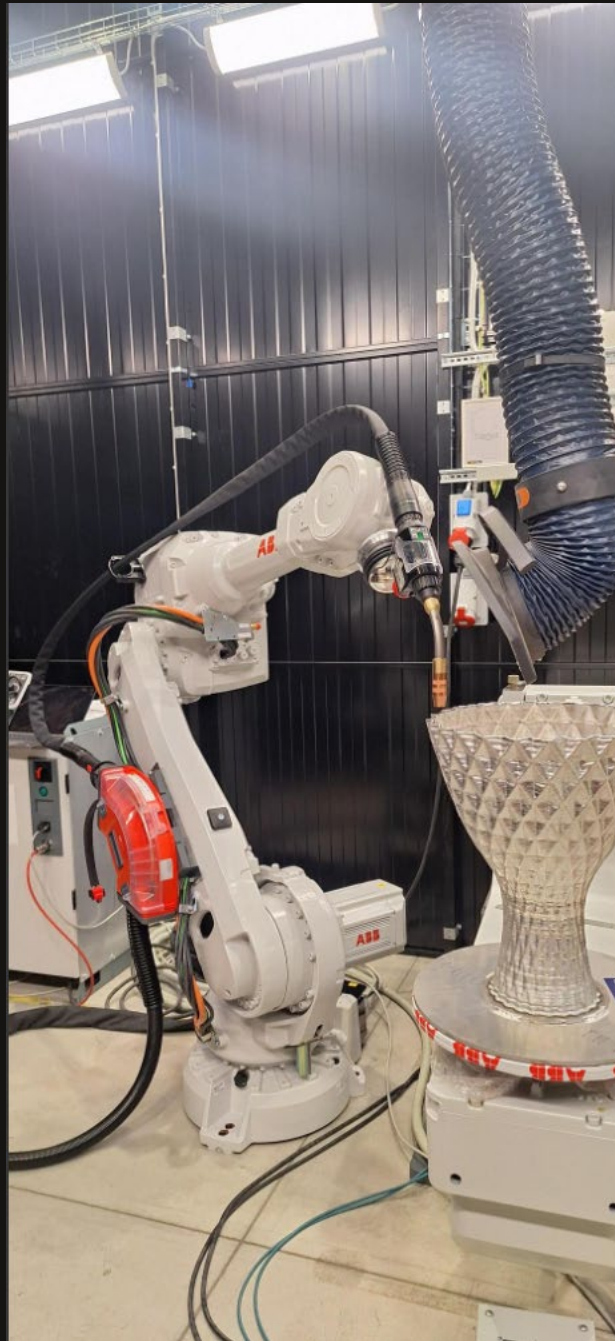
## Documents by affiliation

Compare the document counts for up to 15 affiliations.



**WAAMLABZ?**

**Our new start-up at PTC!**



Decentralized  
WAAM production

**WAAM**  
IBZ

 **WAAM recipes**  
A WAAM recipe is a digitalized digital  
instruction on how to 3D print a  
specific metal component.

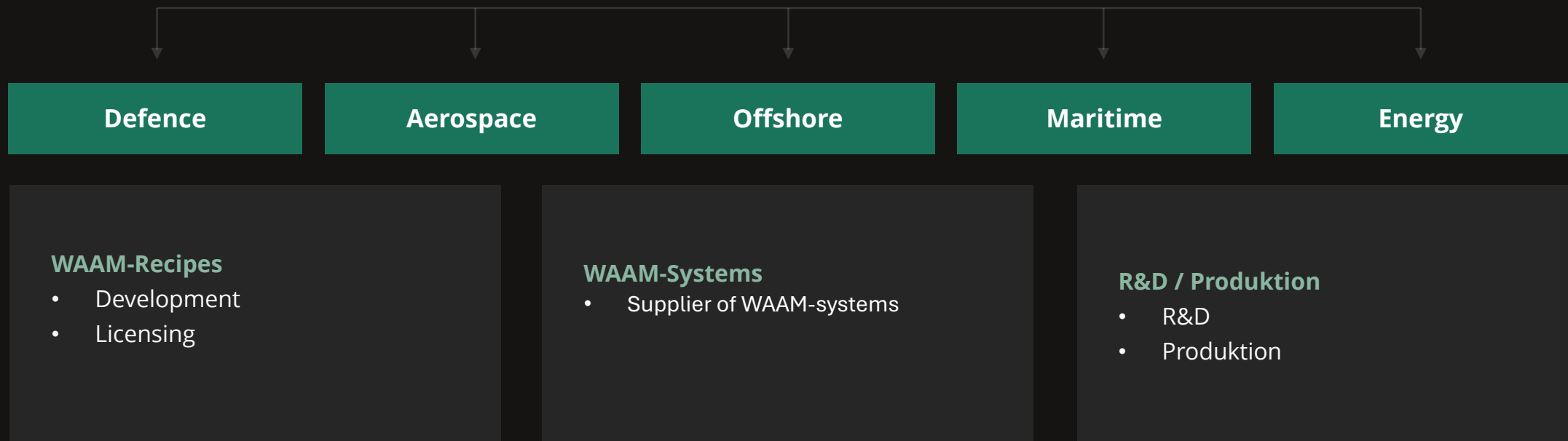
 **WAAM systems**  
We are experts and trusted suppliers  
of advanced WAAM systems.

 **Production / R&D**  
Material savings of 80-90%  
compared to traditional  
manufacturing.

[www.wsamibz.com](http://www.wsamibz.com)

# OFFER – WIRE ARC ADDITIVE MANUFACTURING

WAAMLABZ is one of the few players in the world with the capability and research infrastructure to develop qualified WAAM recipes that enable repeatable production.



# Team



**Joel Andersson**

Chairman & Co-founder



**Eivind Vogel-Rödin**

CEO



**Kjell Hurtig**

CTO



**Mattias Igestrand**

Development Engineer



**Niclas Berglund**

Development Engineer



**Christian Magnusson**

Project management

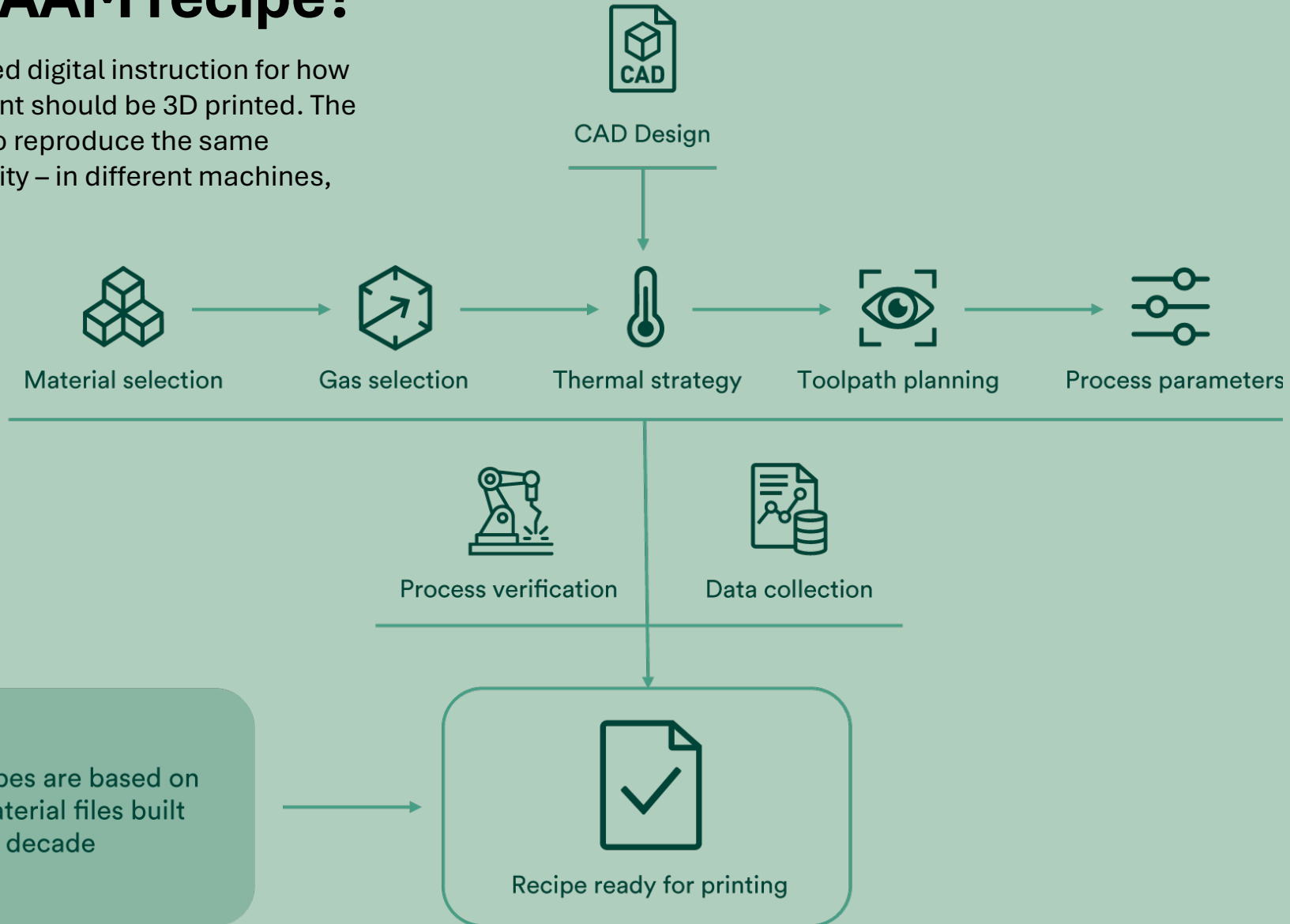


**Jan Björn**

Software developer

# What is a WAAM recipe?

A WAAM recipe is a detailed digital instruction for how a specific metal component should be 3D printed. The recipe makes it possible to reproduce the same component with high quality – in different machines, at different locations.



**Any challenges with AM?**

# Future/present challenges AM?

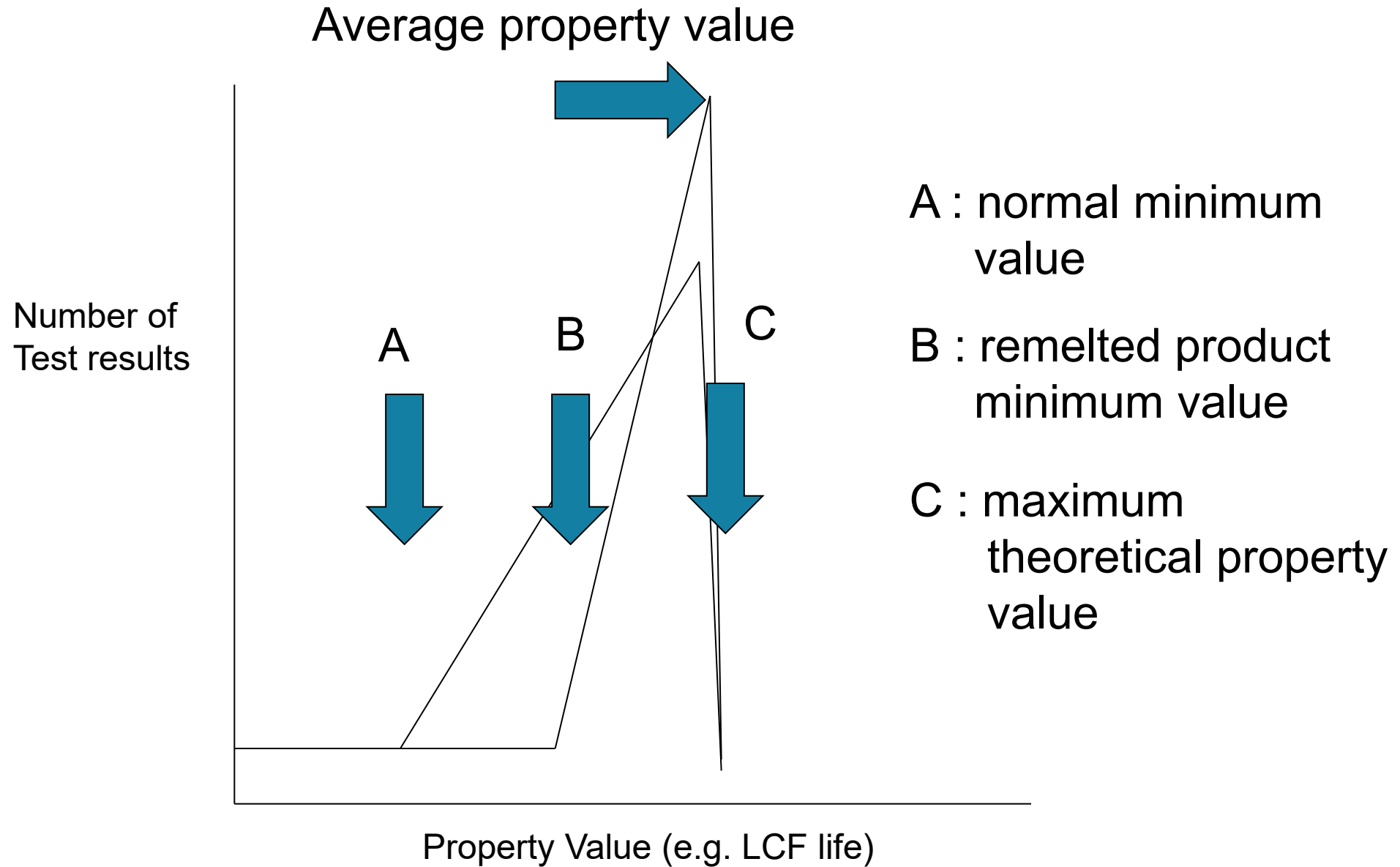
1. Production Costs and Production Scale
2. Material Availability and Development
3. Workforce Education and Skills
4. Adoption and Integration into Existing Manufacturing Ecosystems
5. Cybersecurity and Intellectual Property
6. Process Consistency

# Future/present challenges AM?

- ~~1. Production Costs and Production Scale~~
- ~~2. Material Availability and Development~~
- ~~3. Workforce Education and Skills~~
- ~~4. Adoption and Integration into Existing Manufacturing Ecosystems~~
- ~~5. Cybersecurity and Intellectual Property~~
- 6. Process Consistency**

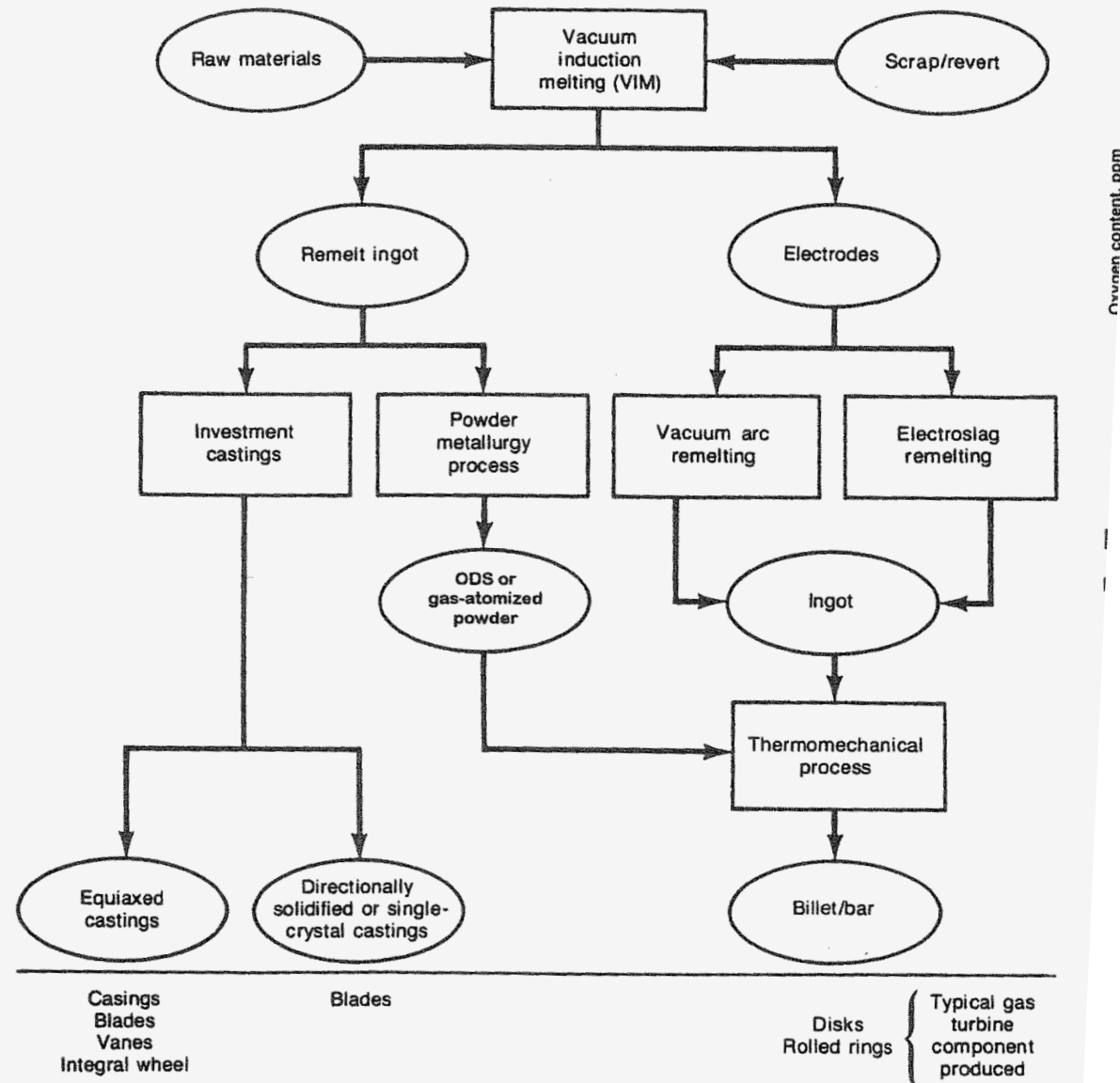
# **Lessons Learned from Traditional Manufacturing of High-Quality Alloys**

**A Key Driver of Research and Development at  
University West and WAAMLABZ!**



What does “High quality” mean?

# Manufacturing Process steps superalloys



**Fig. 21** Flow diagram of processes widely used to produce superalloy components. ODS, oxide-dispersion-strengthened. Source: Ref 26

# Example of “Testing” Problem in Primary Manufacturing

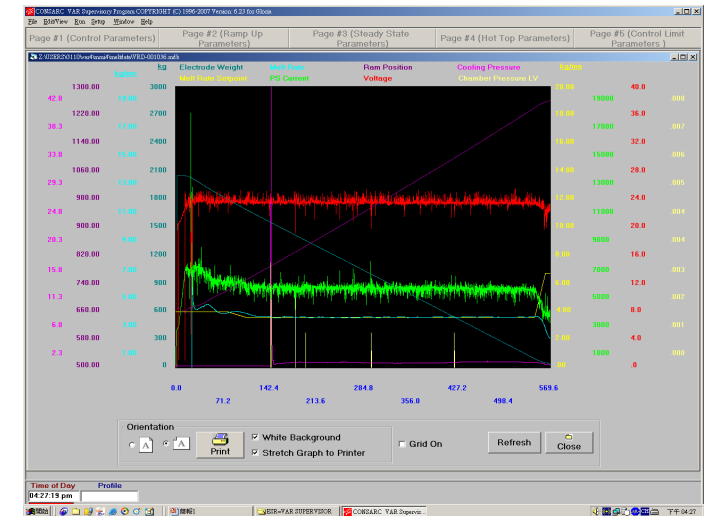
- The remelting processes are the last melting step in high quality alloy production.
- In all these processes, less than 10% of the alloy is liquid at any one time.
- Conventional testing is by examination of samples from T, M & B of the final billet
- How to detect problems in the intervening alloy?

# Quality is directly linked to the melting operation

- “Normal” metallurgical structure, e.g. precipitate size, grain orientation, periodic composition variation in the solidification structure
- Irregularities cause more quality problems than “steady state”.
- Best identified by process examination – testing can easily miss them

# The way it is treated today!!

- Process recording!!
  - I, V, MR, DS, travel, pressure, video etc



Description		
Description	V48-3,IN718	

Current Control Parameters		
Current Limit	7400	A
Hot Top Start Weight	195	kg
Melt End Alarm Weight	35	kg

Drive Control Parameters		
Minimum Trim Speed	80	%
Base Speed On Delay	40	Mn
Trim Speed On Delay	40	Mn

Geometry Parameters		
Quibble Top Diameter	455	mm
Quibble Bottom Diameter	473	mm
Quibble Length	2838	mm
Electrode Top Diameter	(370)	mm
Electrode Bottom Diameter	(380)	mm
Electrode Length	(2800)	mm
Ingot Density	8.2	g/cm <sup>3</sup>
Allowable Geometry Error	20	%

Weight Parameters		
Sub Weight	(252)	kg
Ramp Up Error Mult.	9	K
Weight Error Window	25	kg

Dipsort Parameters		
Nominal Current Level	5000	A
Minimum Current Level	3000	A
Overdrive Constant (xBase)	1.5	K
Overdrive Multiplier (x3P)	3.0	K

Crack / Defect Detect		
[ ] Crack / Defect Algorithm		
Number of Consecutive Melt Rate Error Readings	10	k
Accumulated Melt Rate Error	15.0	%
Defect Duration Time	10.0	Mn
Melt Rate PD Multiplier	1.0	k
Drive PD Multiplier	1.0	k

Setpoint Control Parameters		
Steady State		
• Weight Based Control Mode		
( )	Electrode (Decay)	
(●)	Ingot Weight (Accumulated)	
Hot Top		
• Weight Based Control Mode		
(●)	Electrode (Decay)	
( )	Ingot Weight (Accumulated)	
(●)	Actual Current	
( )	% of Hot Top Start Current	
Time Based Control		
( )	Accumulated Time	
(●)	Minutes per Segment	
Melt Rate Current Control Basis		
(●)	Ending Ramp Up Current	
( )	Time Based Current	

Vacuum Parameters		
Cooling Gas On Delay	500	kg
Pressure On Delay	5000	kg

# Challenge with AM (high quality alloys)?!

- More or less the same!?
  - How to detect problems in the alloy?
    - How to assure quality with realistic amounts of testing
    - How to define “acceptable” quality
    - How to rectify quality issues
    - How to balance testing against process control as the means of quality assurance
    - How to audit processes with a substantial “people” content
    - ...
    - ...
    - ...



- How to solve?????

# Process Irregularities

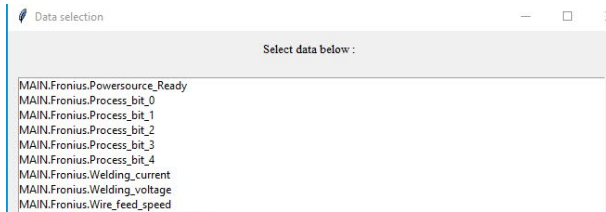
- Detectable from process records!?
- We have knowledge from “traditional manufacturing routes!”
  - freckles, white spots, intermittent centre segregation, internal pores and cracks etc.
- What about AM and the future?



**Process monitoring with adaptive capabilities and automatic “flagging” of deviations!**

# Data logging

- Here we can add what we want to log/record.
- We can add more measuring instruments to the systems.
  - Additional cameras.
  - Thermocouples.
  - Thermal camera
  - Gas mixture
  - Process parameters
  - And what ever you need



This could be zoomed in to see the expanded signals in interested regions

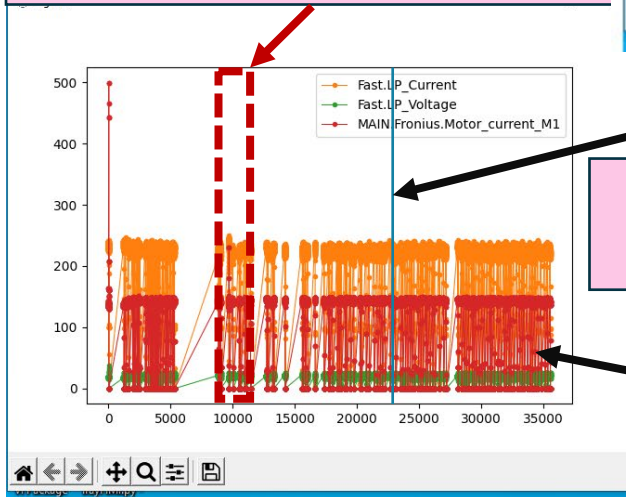
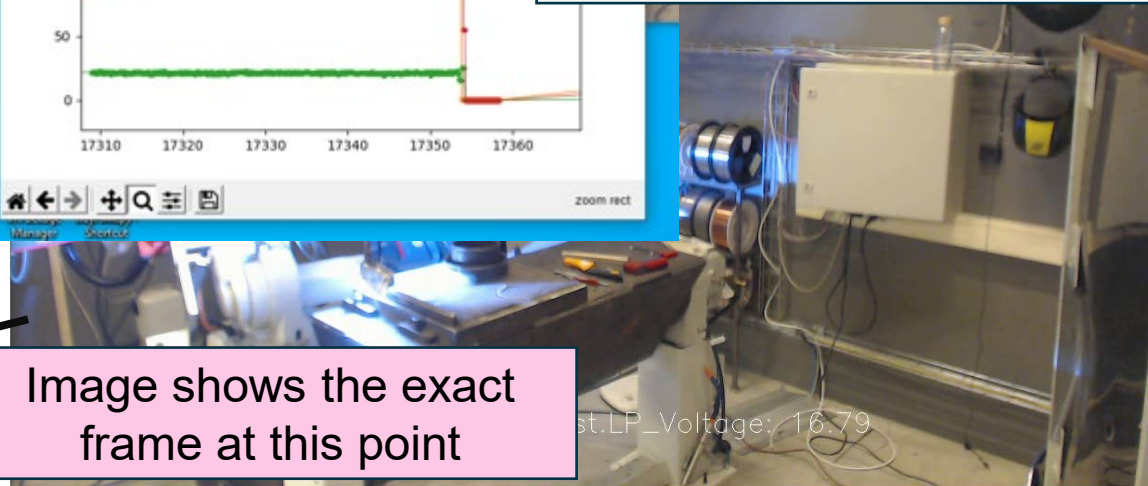


Image shows the exact frame at this point

Current and Voltage variation during deposition

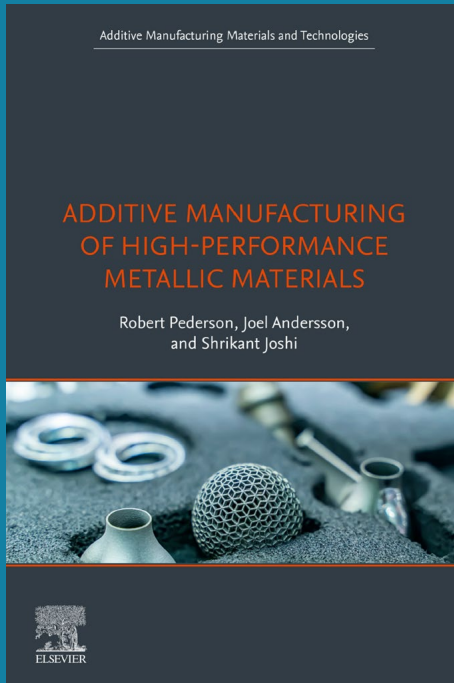


# The step forward?

- Process recording!???
- Process monitoring!!??
  - Process monitoring with adaptive capabilities!!!?
  - Process monitoring with adaptive capabilities and automatic “flagging” of deviations!!!!

# To conclude

- Eco system:
  - Combination of OEMs, SMEs, institutes, universities, and incubators working together in open arenas!
- Global presence
  - WAAM is catching more and more attention!
  - China has until now the strongest presence globally
    - Cranfield University and University of Wollongong are as single entities the ones publishing most!
- Key challenges AM:
  - High Production Costs and Limited Production Scale
  - Material Availability and Development
  - Workforce Education and Skills
  - Adoption and Integration into Existing Manufacturing Ecosystems
  - *Cybersecurity and Intellectual Property*
  - **Technological Advancements and Process Consistency**
    - The way forward?
      - Process monitoring with adaptive capabilities and automatic “flagging” of deviations!



# Thank you!

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Co-Founder WAAMLABZ  
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